122(3586)

Proceedings of the United States National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 122 1967 Number 3586

NEW CYCLOPOID COPEPODS ASSOCIATED WITH THE CORAL PSAMMOCORA CONTIGUA (ESPER) IN MADAGASCAR

By ARTHUR G. HUMES AND JU-SHEY HO

SMITHSONIAN PRESS

Proceedings of the United States National Museum

SMITHSONIAN INSTITUTION • WASHINGTON, D.C.

Volume 122 1967 Number 3586

NEW CYCLOPOID COPEPODS ASSOCIATED WITH THE CORAL PSAMMOCORA CONTIGUA (ESPER) IN MADAGASCAR

By Arthur G. Humes and Ju-Shey Ho [1]

Several species of copepods are known to live in association with madreporarian corals in the region of Nosy Bé, in northwestern Madagascar (Humes, 1962a, 1962b; Humes and Frost, 1964). Only one of these, *Kombia angulata* Humes, 1962, has been recovered from the genus *Psammocora* (family Thamnasteriidae), that is to say, from *Psammocora* species.

An examination of *Psammocora contigua* (Esper) from Ambariobe, a small island situated nearly between Nosy Bé and Nosy Komba, has revealed the four new associated copepods described in this paper.

All collections were made by the senior author while participating in the activities of the U.S. Program in Biology of the International Indian Ocean Expedition at Nosy Bé in 1963–64.

The study of the material has been aided by a grant (GB–1809) from the National Science Foundation.

All figures have been drawn with the aid of a camera lucida. The letter after the explanation of each figure refers to the scale at which it was drawn. Abbreviations used in figures: A_1=first antenna, A_2=second antenna, L=labrum, MD=mandible, P=paragnath,

[1] Both authors: Department of Biology, Boston University, Boston, Massachusetts.

MX_1=first maxilla, MX_2=second maxilla, MXPD=maxilliped, P_1=first leg.

We wish to thank Dr. Michel Pichon for the identification of the coral and to express our appreciation for the many courtesies received from the staff of the Centre d'Océanographie et des Pêches at Nosy Bé.

Family Xarifiidae Humes, 1960

Genus *Xarifia* Humes, 1960

Xarifia diminuta, new species

FIGURES 1–24

TYPE MATERIAL.—148 ♀♀ and 262 ♂♂ washed from a colony of the coral *Psammocora contigua* (Esper) in a depth of 1 m, southeast of Ambariobe, near Nosy Bé, Madagascar. Collected Sept. 6, 1963. Holotype female, allotype, and 155 paratypes (50 ♀♀, 105 ♂♂) deposited in the United States National Museum, Washington; 80 paratypes (30 ♀♀, 50 ♂♂) in the Museum of Comparative Zoology, Cambridge, and in the Zoölogisch Museum, Amsterdam; and the remaining paratypes in the collection of A. G. Humes.

OTHER SPECIMENS (all from *Psammocora contigua* in 1–2 m at Ambariobe, collected during 1963).—10 ♀♀, 2 ♂♂, Sept. 6; 143 ♀♀, 87 ♂♂, Sept. 8; 173 ♀♀, 116 ♂♂, Sept. 17; and 65 ♀♀, 30 ♂♂, Oct. 6.

FEMALE.—Body (figs. 1, 2) moderately slender, about five times longer than wide. Length (not including setae on caudal rami) 0.98 mm (0.78–1.18 mm), greatest width 0.18 mm (0.14–0.21 mm), based on 10 specimens. Segmentation not defined externally. Region dorsal to fifth legs bearing three long, posteriorly directed processes, median one only slightly shorter than lateral ones. Genital and postgenital segments together (fig. 3) less than one-fifth total body length. Areas of attachment of egg sacs dorsal in position. Behind these areas a pair of minute ventrolateral setules. Caudal ramus (fig. 4) 45μ x 17μ (width taken at middle), about 2.65 times longer than wide; with four short naked setae (one outer and subterminal, others terminal) and a few minute setules. Egg sac (fig. 5), in one female 290μ x 198μ, containing usually five eggs in a flattened cluster (in some females six or seven), eggs about 97μ in average diameter.

Rostral area protuberant in lateral view (fig. 6) between bases of first antennae and bearing relatively long slender setules (fig. 7). First antenna (fig. 7) short (48μ in length without setae) and apparently 3-segmented, though middle segment showing partial division. With numerous naked setae, armature being 3, 20+1 aesthete, and 8+2 aesthetes. Second antenna (fig. 8) 4-segmented, formula being

1, 1, 2, and I,1 (the Roman numeral referring to the claw). Recurved claw on last segment 6μ in length, slender seta 17μ.

Labrum with posteroventral border having two widely separated lateral lobes (fig. 9). Mandible (fig. 10) with an attenuated blade concealed in ventral view under posterior part of labrum (see fig. 9). Paragnath absent. First maxilla (fig. 11) a small rounded lobe bearing two naked setae. Second maxilla (fig. 12) probably 2-segmented, though separation of segments not complete. Second segment bearing two inner elements (a slender setule and a stout hyaline seta) and terminating in a finger-like process with a hyaline lamellate inner margin. Maxilliped (fig. 13) 2-segmented, second segment bearing two small naked setae and terminating in 2 irregular lobate processes.

Legs 1–4 with general form and segmentation like that shown for leg 1 in figure 14; exopods 3-segmented (the articulation obscure), endopods 2-segmented. Spine and setal formula as follows (Roman numerals indicating spines, Arabic numerals setae):

P_1	protopod	0–0	1–0	exp	I–0	I–0	I,3
				end	0–0	2	
P_2	protopod	0–0	1–0	exp	I–0	I–0	I,3
				end	0–0	2	
P_3	protopod	0–0	1–0	exp	I–0	I–0	I,2
				end	0–0	0	
P_4	protopod	0–0	1–0	exp	I–0	I–0	I,2
				end	0–0	2	

In all four legs coxa with a slender setule on posterior outer surface; basis with an outer naked seta and an inner tuft of long hairs. Exopod with stout spines recurved posteriorly (fig. 15); three small slender setae at inner base of terminal spine in legs 1 and 2, two such setae in legs 3 and 4. Long hairs arising from inner margins of first and second segments of exopod. Endopod with long hairs on outer margins of both segments; last segments with two terminal setae in legs 1, 2, and 4, but unarmed in leg 3 (fig. 16).

Leg 5 (fig. 17) elongated and slender, with its free segment not clearly delimited from body. Segment about 120μ in length and somewhat irregular in width, tapered distally, bearing two unequal terminal naked setae 13μ and 26μ long. A slender seta arising from body wall dorsal to base of segment. Leg 6 absent.

Color in life in transmitted light slightly reddish brown, eye red, egg sacs orange red to reddish green.

MALE.—Body (figs. 18, 19) rather slender, slightly longer than female. Length 1.15 mm (0.94–1.35 mm), greatest width 0.16 mm (0.13–0.19 mm), based on 10 specimens. Without external segmentation. Caudal ramus (fig. 20) shorter than in female and not distinctly delimited from anal segment.

Rostral area (fig. 21) as in female. First antenna like that of female but with four aesthetes, one being added on midanterior margin of middle segment. Second antenna, labrum (see fig. 21), mandible, first maxilla, and second maxilla resembling those in female. Paragnath absent. Maxilliped (fig. 22) 4-segmented. First segment short and unarmed. Second large and swollen with two inner setae (one sclerotized proximally, other entirely hyaline) and having its distal outer surface minutely punctate. Third segment very short and unarmed. Fourth segment forming a terminal claw 39μ along its axis, bifurcated at its tip, with an outer hyaline lamella and an inner triangular hyaline process; bearing two setae (one sclerotized proximally, other entirely hyaline).

Legs 1–4 as in female, with same spine and setal forumla. Leg 5 (fig. 23) without a distinct segment and consisting of three small setae, the two more ventral ones forming a pair and probably homologous to the two setae on the end of leg 5 in the female. Leg 6 (figs. 19, 23) represented by a ventrolateral flap bearing two small setae.

Spermatophore (fig. 24) elongated, 255μ x 62μ, not including neck.

Color as in female.

ETYMOLOGY.—The specific name *diminuta*, from Latin=diminished, refers to the relatively small size of this species.

METHOD OF COLLECTION AND RELATION TO HOST.—The number of specimens of *X. diminuta* collected from *Psammocora contigua* depended upon the technique employed. When the corals were washed in weakly alcoholized sea water (with about 5 per cent ethyl alcohol) within one or two hours after being brought to the laboratory, few if any *Xarifia* were obtained. After crushing the corals with a hammer, relatively few *Xarifia* were recovered from the debris and mucus. When, however, the corals were left overnight (12–14 hours) in pails of alcoholized sea water, abundant specimens of the copepods were found in the sediment. This is in accord with the observations of Humes (1962a) on the collection of other species of *Xarifia*. Gerlach, as quoted by Humes (1960), observed that living *Xarifia* in *Pocillopora* in the Maldive Islands crawl about on the surface of the coral but may at times enter the polyps where they seem to tear up the tissue of the coral.

COMPARISON WITH RELATED SPECIES.—There are 10 species presently known in the genus *Xarifia*. *X. diminuta* may be distinguished from eight of these which have the endopods of legs 1–4 composed of a single segment (*X. maldivensis* Humes, 1960; *X. fimbriata* Humes, 1960; *X. gerlachi* Humes, 1962; *X. longipes* Humes, 1962; *X. reducta* Humes, 1962; *X. serrata* Humes, 1962; *X. tenuis* Humes, 1962; and *X. infrequens* Humes, 1962). In the two remaining species, *X. dispar* Humes, 1962, and *X. comata* Humes, 1962, the endopods of legs 1–4 are

2-segmented. The new species differs from *X. dispar*, which is larger (both sexes about 1.4 mm in length), has slender spines on the first two segments of the exopods in legs 1–4, has shorter processes on the region dorsal to the fifth legs, and has a terminal seta on the endopod of leg 3. It seems to be close to *X. comata*, with its fifth legs and three processes dorsal to them being similar to those in that species. *X. diminuta* differs from *X. comata*, however, in the following features: the first segment of the exopods of legs 1–4 has a well-developed outer spine (this spine minute in *X. comata*), the second segment of the exopods of legs 1–4 has an outer spine (lacking in *X. comata*), the endopod of leg 3 lacks terminal elements (two setae in *X. comata*), the endopod of leg 4 has two terminal setae (only one in *X. comata*), the terminal spine and seta of the second antenna are very unequal in length (nearly equal in *X. comata*), the egg sac usually contains five eggs (sometimes six or seven) (in *X. comata* usually two, sometimes one, three, or four), and the maxilliped of the male has a form different from that of *X. comata*.

Family Lichomolgidae Kossmann, 1877

Genus *Lichomolgus* Thorell, 1860

Lichomolgus rhadinus, new species

FIGURES 25–51

TYPE MATERIAL.—199 ♀♀, 227 ♂♂, and 9 copepodids washed from the coral *Psammocora contigua* (Esper) in a depth of 2 m, south of Ambariobe, near Nosy Bé, Madagascar. Collected Sept. 8, 1963. Holotype female, allotype, and 160 paratypes (88 ♀♀, 72 ♂♂) deposited in the United States National Museum, Washington; 85 paratypes (35 ♀♀, 50 ♂♂) in the Museum of Comparative Zoology, Cambridge, and in the Zoölogisch Museum, Amsterdam; and the remaining paratypes in the collection of A. G. Humes.

OTHER SPECIMENS (all from *Psammocora contigua* in 1–2 m at Ambariobe, collected during 1963).—33 ♀♀, 18 ♂♂, Sept. 6; 83 ♀♀, 39 ♂♂, Sept. 8; 9 ♀♀, Sept. 17; and 3 ♀♀, 1 ♂, Oct. 6.

FEMALE.—Body (fig. 25) moderately slender. Length (not including setae on caudal rami) 1.00 mm (0.95–1.04 mm) and greatest width 0.35 mm (0.33–0.36 mm), based on 10 specimens. Ratio of length to width of prosome 1.70:1. Segment of leg 1 separated from head by a dorsal furrow. Epimeral areas of metasomal segments formed as illustrated in figure.

Segment of leg 5 (fig. 26) 47μ x 105μ. Between this segment and genital segment a short ventral intersegmental sclerite. Genital segment about as long as wide, 110μ x 108μ, rather abruptly constricted in its posterior fourth. Areas of attachment of egg sacs situated dorsally (only slightly laterally), each area (fig. 27) bearing two small

setae 5μ and 8μ in length. Three postgenital segments 50μ x 55μ, 39μ x 48μ, and 50μ x 47μ from anterior to posterior. Anal segment with a row of minute spinules along its posteroventral margin on each side.

Caudal ramus (fig. 28) elongated, 73μ x 22μ, about 3.3 times longer than wide. Outer lateral seta 88μ and naked; outermost terminal seta 91μ and naked; innermost terminal seta 112μ with inner hairs proximally. Two long median terminal setae 255μ (inner) and 203μ (outer) with lateral spinules in their midregions; these two setae inserted between dorsal (smooth) and ventral (with a row of minute spinules) flaps. Dorsal pedicellate seta 57μ and naked. Dorsal surface of ramus with scattered hairs.

Dorsal surface of prosome and urosome with few hairs (as in figs. 25, 26); ventral surface of urosome almost devoid of ornamentation. Ratio of length of prosome to that of urosome 1.85:1.

Egg sac (fig. 25) about 278μ x 170μ, containing a relatively small number of large eggs (five–seven), each egg about 92μ in average diameter.

Rostral area (fig. 29) not well developed, without a definite posteroventral margin.

First antenna (fig. 30) slender (280μ in length) and 7-segmented, with sclerite on third segment suggesting an intercalary segment weakly developed. Lengths of segments (measured along their posterior nonsetiferous margins) 28μ (44μ along anterior margin), 99μ, 28μ, 52μ, 28μ, 23μ, and 11μ respectively. Formula for armature, as in other species of *Lichomolgus*, 4, 13 (5+8), 6, 3, 4+1 aesthete, 2+1 aesthete, and 7+1 aesthete. All setae naked.

Second antenna (fig. 31) 4-segmented, slender, and elongated (208μ in length). Outer edge of penultimate segment 52μ in length, and that of last segment 21μ. Armature 1, 1, 3, and I, 1. All setae small and naked; terminal claw 28μ along its axis. Row of slender spinules on inner surface of second segment distal to seta.

Labrum (fig. 32) with two posteroventral lobes.

Mandible (fig. 33) with proximal region constricted, a narrow waist separating basal and distal parts. That part distal to waist having on its inner side a prominent elongated posteriorly directed process followed by a row of minute blunt hyaline spinules; and on its outer side a bilobed margin with setules. Flagellum moderately long with lateral spinules. Paragnath (fig. 37) a prominent well-sclerotized lobe without visible ornamentation but with its distal surface slightly wrinkled. First maxilla (fig. 34) with 3 terminal elements. Second maxilla (fig. 35) 2-segmented. First segment unornamented. Second segment having on its outer (ventral) margin a small proximal setule followed by a seta and on its inner

(dorsal) margin a seta with hyaline lamellae; terminal lash with a row of slender spinules. Maxilliped (fig. 36) 3-segmented. First segment stout and unornamented. Second segment elongated and slender with two inner setae. Third segment with two small setae and a terminal spiniform process with lateral spinules.

Area between maxillipeds and first pair of legs (fig. 37) not protuberant; sclerotized line between bases of maxillipeds.

Legs 1–4 (figs. 38–41) with trimerous rami except for endopod of leg 4 which is 2-segmented. Armature as follows (Roman numerals indicating spines, Arabic numerals setae):

P_1	protopod	0–1	1–0	exp	I–0	I–1	III, I, 4
				end	0–1	0–1	I, 5
P_2	protopod	0–1	1–0	exp	I–0	I–1	III, I, 5
				end	0–1	0–2	I, II, 3
P_3	protopod	0–1	1–0	exp	I–0	I–1	III, I, 5
				end	0–1	0–2	I, II, 2
P_4	protopod	0–0	1–0	exp	I–0	I–1	II, I, 5
				end	0–1	2	

Inner seta on coxa of legs 1 and 2 long and plumose, in leg 3 somewhat reduced in size, and in leg 4 absent. Hairs present on inner margin of basis in legs 1–3 but absent in leg 4. Outer spines on exopod of leg 1 flagellated. Endopod of leg 4 with hairs along outer margins of both segments. First segment 17μ x 13μ with plumose inner seta 26μ long; second segment 29μ long, 9μ wide proximally, 7μ wide distally, and armed with two slightly barbed setae 22μ (outer) and 33μ (inner).

Leg 5 (fig. 42) with an elongated free segment having a proximal inner expansion. This segment 90μ in length, 22μ wide at the expansion, and 17μ wide in its midregion; with a few small spinules on outer dorsal surface of distal half and with two terminal naked setae, outer 44μ, inner 72μ in length. Seta on body near free segment 68μ and slightly haired distally. A few small outer spinules near insertion of free segment.

Leg 6 probably represented by 2 setae near attachment of each egg sac (see fig. 27).

Color in life in transmitted light translucent, eye red, ovary black.

MALE.—Body (fig. 43) slender. Length (without setae on caudal rami) 0.73 mm (0.69–0.76 mm) and greatest width 0.23 (0.22–0.24 mm), based on 10 specimens. Ratio of length to width of prosome 1.72:1.

Segment of leg 5 (fig. 44) 32μ x 73μ. Between this segment and genital segment no ventral intersegmental sclerite. Genital segment longer than wide, 169μ x 135μ. Four postgenital segments 24μ x 43μ, 26μ x 42μ, 21μ x 40μ, and 31μ x 42μ from anterior to posterior.

Caudal ramus (fig. 45) resembling that of female but much shorter, 28μ x 18μ, or 1.55 times longer than wide.

Dorsal surface of body with few hairs (as in figs. 43, 44); ventral surface of urosome almost completely lacking ornamentation. Ratio of length of prosome to that of urosome 1.43:1.

Rostral area like that of female.

First antenna similar to that of female but with 3 aesthetes added, so that formula is 4, 13+2 aesthetes, 6, 3+1 aesthete, 4+1 aesthete, 2+1 aesthete, and 7+1 aesthete. Second antenna resembling that of female but inner margin of second segment with a row of dentiform spinules (fig. 46).

Labrum, mandible, paragnath, first maxilla, and second maxilla similar to those in female. Maxilliped (fig. 47) elongated and slender, 4-segmented, assuming that proximal part of claw represents a fourth segment. First segment unarmed, second with two setae and rows of spinules on inner surface, third short and unarmed. Claw slender and gently recurved, 127μ along its axis (including terminal lamella), with faint indication of division about midway; two unequal setae on proximal part of claw.

Legs 1–4 as in female except for endopod of leg 1 where formula for last segment (fig. 48) is I,I,4, instead of I,5 as in female.

Leg 5 (fig. 49) with elongated free segment, 18μ x 6μ, lacking a basal expansion. Two terminal setae 8μ (inner) and 24μ (outer).

Leg 6 (fig. 50) a posteroventral flap on genital segment bearing two naked setae 18μ and 22μ long.

Spermatophore (fig. 51) moderately elongated, 127μ x 56μ (without neck), often attached to female in pairs.

Color in life in transmitted light similar to that of female.

ETYMOLOGY.—The specific name *rhadinus*, from the Greek word ῥαδινός=slender, refers to the slender form of the body, of the first and second antennae, and of the maxillipeds in this species.

METHOD OF COLLECTION AND RELATION TO HOST.—*Lichomolgus rhadinus* was recovered after washing the coral in alcoholized sea water within a few hours after collection. In contrast to the recovery of *Xarifia diminuta* and *Rhynchomolgus corallophilus*, where the greatest numbers of specimens were found after allowing the coral to remain in alcoholized sea water overnight or after crushing the coral, all *L. rhadinus* were obtained in the first washings and none were found in the second washings after an overnight delay or after crushing. This suggests that *L. rhadinus* lives on the surface of the coral whence it is easily dislodged, rather than in the polyps.

COMPARISON WITH RELATED SPECIES.—The distinctive form of the mandible in *L. rhadinus* sets it apart from almost all of the other 70 or more species already described in the genus. Only five species

have a mandible somewhat resembling that of the new species. *L. actinophorus* Humes and Frost, 1964, has an elongated posteriorly directed process on the inner side of the basal region, but this process is more pointed and dentiform than in *L. rhadinus*. In addition, *L. actinophorus* differs from *L. rhadinus* in lacking a basal expansion on leg 5 in the female. Four species show on the inner basal region of the mandible a dentiform process much shorter than in *L. rhadinus*. These are *L. decorus* Humes and Frost, 1964 (in which the last segment of the exopod of leg 4 is III,I,4), ?*L.* (*Epimolgus*) *protulae* Stock, 1959 (with no basal expansion on leg 5 in the female and with the last segment of the second antenna bearing three strong claws, three setiform claws, and one seta), and *L. organicus* Humes and Ho, 1967, and *L. conjunctus* Humes and Ho, 1967, from the alcyonarian coral *Tubipora musica*. In both of these there is no basal expansion on leg 5 in the female and the last segment of the second antenna bears two claws and five setae. All other species of *Lichomolgus* in which the mandible has been described or figured lack prominent processes of this sort.

Eight species of *Lichomolgus* can not be compared with *L. rhadinus* in respect to the mandible since that appendage in them is unknown. They may be easily separated from the new species, however, on other grounds. *L. dentipes* Thompson and A. Scott, 1903, and *L. rigidus* (Ummerkutty, 1962) have the formula III,I,5 on the last segment of the exopod of leg 4. *L. elegans* Thompson and A. Scott, 1903, has in the female a much shorter caudal ramus and leg 5 without a basal expansion. *L. gigas* Thompson and A. Scott, 1903, is much larger (female 2 mm) and leg 5 lacks a basal expansion. *L. longipes* (Sewell, 1949), *L. rotundus* Sewell, 1949, *L. tenuicornis* Brady, 1910, and *L. vagans* Gurney, 1927, have two claws included in the armature of the last segment of the second antenna.

L. rhadinus appears to be most closely related to *L. actinophorus* Humes and Frost, 1964. It is of interest to note here the strong similarity between the mandible of *L. rhadinus* and that of *Rhynchomolgus corallophilus* (compare figs. 33 and 90). In many other features, however, these two copepods from *Psammocora* are very different.

Genus *Monomolgus* Humes and Frost, 1964

Monomolgus psammocorae, new species

FIGURES 52–79

TYPE MATERIAL.—17 ♀♀, 27 ♂♂, and 2 copepodids washed from the coral *Psammocora contigua* (Esper) in a depth of 2 m, southeast of Ambariobe, near Nosy Bé, Madagascar. Collected Sept. 8, 1963. Holotype female, allotype, and 32 paratypes (12 ♀♀, 20 ♂♂) deposited

in the United States National Museum, Washington; 6 paratypes (2 ♀♀, 4 ♂♂) in the Zoölogisch Museum, Amsterdam; and the remaining paratypes in the collection of A. G. Humes.

Other specimens (all from *Psammocora contigua* in 1 m at Ambariobe, collected during 1963).—9 ♀♀, 8 ♂♂, Sept. 6; 2 ♀♀, 2 ♂♂, Sept. 17; and 10 ♀♀, 3 ♂♂, Oct. 6.

Female.—Body (fig. 52) with broadened prosome. Length (excluding setae on caudal rami) 1.25 mm (1.21–1.29 mm) and greatest width 0.65 mm (0.62–0.68 mm), based on 10 specimens. Ratio of length to width of prosome 1.22:1. Segment of leg 1 separated from head by a dorsal furrow. Epimeral areas of segments of legs 1–3 expanded as shown in figure. Segment of leg 4 without such expanded areas.

Segment of leg 5 (fig. 53) 86μ x 213μ. Between this segment and genital segment a short ventral intersegmental sclerite. Genital segment wider than long, 146μ x 172μ, broadest in its anterior half and tapered posteriorly. Areas of attachment of egg sacs situated laterally (only slightly dorsally), each area (fig. 54) bearing two setae 10μ and 6μ in length, with a short spinous process between them. Three postgenital segments 73μ x 99μ, 62μ x 96μ, and 68μ x 97μ from anterior to posterior. Anal segment posteriorly with row of small spinules laterally and ventrally on each side.

Caudal ramus (fig. 55) moderately elongated, 92μ x 35μ in greatest dimensions (77μ along inner edge, 90μ along outer edge). Ratio of length to width 2.63:1. Outer lateral seta 57μ long with minute barbules; outermost terminal seta 58μ and innermost terminal seta 75μ, both with proximal hairs and distal barbules as in figures. Two long median terminal setae 237μ (inner) and 146μ (outer) with proximal spinules and distal barbules; these two setae inserted between dorsal and ventral flaps (both with a row of slender spinules). Dorsal pedicellate seta 37μ and naked. Dorsal surface of ramus with a few hairs and two small hyaline spinules.

Dorsal surface of prosome and urosome with scattered hairs (as in figs. 52, 53); ventral surface of urosome sparsely ornamented. Ratio of length of prosome to that of urosome 1.72:1.

Egg sac (figs. 52, 56) attached in somewhat oblique position, with posterior end lying dorsally over postgenital segments. In lateral view egg sac in one female 400μ x 285μ, containing about 12 large eggs, with their diameters 117μ–130μ.

Rostral area (fig. 57) with broadly rounded posterior margin.

First antenna (fig. 58) 7-segmented, with a small sclerite on third segment suggesting an intercalary segment. Lengths of segments (measured along their posterior nonsetiferous margins) 55μ (71μ along anterior margin), 62μ, 28μ, 28μ, 32μ, 33μ, and 18μ, respectively.

Formula for armature: 4, 13 (5+2+6), 6, 3, 4+1 aesthete, 2+1 aesthete, and 7+1 aesthete. All setae naked. Row of minute spinules on first segment.

Second antenna (fig. 59) 4-segmented, last segment 50μ x 20μ. Armature 1, 1, 3, I, with terminal claw 43μ along its axis. A few minute spinules near bases of setae on third segment; two small setules on opposite surfaces of last segment near insertion of claw.

Labrum (fig. 60) with two posteroventral lobes and bearing numerous hairs.

Mandible (fig. 61) with its inner basal margin smooth, its outer basal margin with a distal row of slender setules and a proximal auricular expansion encircled with setules; lash elongated, its proximal inner margin with blunt hyaline dentations, both margins distal to this with spinules. Paragnath (fig. 62) an elongated lobe with distal hairs. First maxilla (fig. 63) with four elements as in figure. Second maxilla (fig. 64) 2-segmented. First segment somewhat swollen distoventrally, with small spinules. Second segment with a seta (having hyaline lamellae) on its anterior surface, a hyaline element on its inner (dorsal) margin, and a very small setule proximally on its outer (ventral) margin; distal part of segment forming a lash with a marginal row of three large slender proximal teeth gradating rapidly to many slender setules; a crescent of minute spinules at base of lash. Maxilliped (fig. 65) 3-segmented, first segment unarmed, second segment with two naked setae and a short row of minute spinules, and small third segment terminally with a spine, two hyaline setae, and a spinelike process with lateral spinules.

Area between maxillipeds and first pair of legs (fig. 66) not protuberant; sclerotized line connecting bases of maxillipeds.

Legs 1–4 (figs. 67–70) with trimerous rami except for endopod of leg 4 which consists of two segments. Armature as follows (Roman numerals indicating spines, Arabic numerals setae):

P_1	protopod	0–1	1–0	exp	I–0	I–1	III,I,4
				end	0–1	0–1	I,5
P_2	protopod	0–1	1–0	exp	I–0	I–1	III,I,5
				end	0–1	0–2	II,I,3
P_3	protopod	0–1	1–0	exp	I–0	I–1	III,I,5
				end	0–1	0–2	I,I,2
P_4	protopod	0–1	1–0	exp	I–0	I–1	II,I,5
				end	0–0	I	

Inner seta on coxa of legs 1–3 long and plumose, but in leg 4 very small (3μ long) and naked. Lamellae on spines of leg 1 more conspicuously spinulose than in legs 2–4. Spinules in row across distal margin of second segment of endopod of legs 1–3 much larger than those on first segment of these endopods. Endopod of leg 4 with both segments having inner and outer hairs. First segment 23μ x 18.5μ;

second segment 29μ x 13μ, armed with a single terminal spine 50μ in length having minutely spinulose lamellae.

Leg 5 in flat view of anterior surface as shown in figure 71, but in undissected specimens appearing in dorsal view as in figure 72. Free segment elongated and moderately broad, 84μ x 28μ, or three times longer than wide; with a few small spinules on its distal anterior surface and armed with two terminal barbed setae 77μ (outer) and 94μ (inner) in length. Seta on body near free segment 70μ long, haired proximally and barbed distally.

Leg 6 probably represented by two setae near attachment of each egg sac (see fig. 54).

Color in life in transmitted light amber in metasomal region, eye red, ovary gray.

MALE.—Body (fig. 73) with prosome broadened, but a little more spherical in dorsal outline than in female. Length (not including setae on caudal rami) 0.91 mm (0.85–0.97 mm) and greatest width 0.37 mm (0.36–0.38 mm), based on 10 specimens. Ratio of length to width of prosome 1.40 : 1.

Segment of leg 5 (fig. 74) 34μ x 138μ. Between this segment and genital segment no ventral intersegmental sclerite. Genital segment in dorsal view broadly expanded, wider than long, 146μ x 208μ. Four postgenital segments 32μ x 60μ, 33μ x 60μ, 34μ x 58μ, and 33μ x 62μ from anterior to posterior.

Caudal ramus resembling that of female but smaller, 68μ x 26μ.

Dorsal surface of prosome and urosome with scattered hairs (as in figs. 73, 74); ventral surface of urosome almost without ornamentation. Ratio of length of prosome to that of urosome 1.45:1.

Rostral area like that of female.

First antenna (fig. 75) resembling that of female but with three aesthetes added. Lengths of segments (measured as in female) 30μ (50μ along anterior margin), 46μ, 15μ, 14μ, 21μ, 14μ, and 13μ, respectively. Formula for armature: 4, 13+2 aesthetes, 6, 3+1 aesthete, 4+1 aesthete, 2+1 aesthete, and 7+1 aesthete. All setae naked.

Second antenna, labrum, mandible, paragnath, first maxilla, and second maxilla as in female. Maxilliped (fig. 76) elongated and slender, 4-segmented, assuming that proximal part of claw represents a fourth segment. First segment unarmed, second with two naked setae and a row of small blunt spines, third very short and unarmed. Claw strongly recurved, 57μ along its axis (including the lamella), with suggestion of bipartite nature midway along its length; proximal part bearing two unequal setae.

Area between maxillipeds and first pair of legs resembling that of female. Legs 1–4 as in female, without sexual dimorphism in endopod

of leg 1. Endopod of leg 4 with dimensions proportionally much like those in female; first segment 19μ x 17.5μ, second segment 24μ x 11μ, and terminal spine 40.5μ.

Leg 5 in flat anterior view as shown in figure 77, but in undissected specimens appearing in dorsal view as in figure 78. Free segment more rectangular than in female, 34μ x 14μ, or 2.43 times longer than wide; terminal setae 51μ and 69μ in length, respectively.

Leg 6 (fig. 79) a posteroventral flap on genital segment bearing two setae, one 50μ in length and naked, other 45μ with a few lateral hairs.

Spermatophore not observed.

Color in life in transmitted light similar to that of female.

ETYMOLOGY.—The specific name *psammocorae* is based on the generic name of the host.

METHOD OF COLLECTION AND RELATION TO HOST.—Like the preceding species, *M. psammocorae* was recovered in greatest numbers from the first washings of the coral, without allowing the coral to stand overnight in alcoholized sea water and without crushing. Presumably the copepod lives on the surface of the coral rather than in the polyps.

SYSTEMATIC POSITION.—The genus *Monomolgus* is at present founded on a single species, *M. unihastatus* Humes and Frost, 1964, associated with a coral, *Porites* cf. *P. andrewsi* Vaughan (family Poritidae), in Madagascar.

The new species from *Psammocora* may readily be distinguished without dissection from *M. unihastatus* by its shorter and more compact body form, its shorter caudal ramus (in *M. unihastatus* 3.9 times longer than wide in the female, 5.7 times in the male), and its narrower free segment of leg 5 in the female (in *M. unihastatus* 1.7 times longer than wide).

M. psammocorae is similar to *M. unihastatus* in several basic respects, particularly the segmentation and armature of the first antenna, second antenna, leg 1 in the female, leg 2, the exopod of leg 3, the endopod of leg 4, and leg 5. The differences seen in leg 1 of the male (lack of sexual dimorphism in *M. psammocorae*), in the endopod of leg 3 (last segment I,I,2, instead of I,II,2), and in the exopod of leg 4 (last segment II,I,5, instead of III,I,5) are probably only of a specific rather than generic nature.

The mouthparts of *M. psammocorae* exhibit certain detailed differences from those of *M. unihastatus*. The mandible in the species from *Psammocora* has an outer basal auricular expansion and a relatively long terminal lash. The paragnath is elongated. The first maxilla is armed with four elements.

These differences are probably not to be construed as evidence against the congeneric position of the two species; comparable differences in mouthparts exist among the species of the genus *Lichomolgus*. The points of similarity are so great that we think it preferable for the present to regard *M. unihastatus* and *M. psammocorae* as members of the same genus. The form of the endopod of leg 4, regarded as especially diagnostic in lichomolgid copepods, supports this point of view.

The inclusion of *M. psammocorae* in *Monomolgus* will necessitate a revision of the original generic diagnosis, especially in relation to the mandible. We are not attempting such a revision at present, however, in the expectation that further studies will clarify the generic concept of *Monomolgus*.

Rhynchomolgus, new genus

Female.—Cephalosome expanded, urosome narrow. Segment of leg 1 fused with head. Urosome 5-segmented. Rostrum tumid and snoutlike. First antenna 5-segmented. Second antenna 4-segmented with a single terminal claw. Mouthparts lichomolgid. Legs 1 and 2 with 2-segmented rami. Leg 3 reduced to two setae. Leg 4 represented by a single seta. Leg 5 consisting of three setae, without a free segment.

Male.—Body elongated and rather vermiform. Segment of leg 1 fused with head. Urosome 5-segmented in immature male, 6-segmented in mature male. Caudal ramus reduced and lobate. Rostrum as in female. First antenna 1-segmented. Second antenna indistinctly 3-segmented. Labrum bulbous. Mandibles, paragnaths, and first maxillae absent. Second maxilla a well-developed hook in immature male, a minute spinous process in mature male. Maxilliped 1-segmented with clawlike tip in immature male, absent in mature male. Legs 1 and 2 much reduced, with rami of one segment. Leg 3 represented by a single seta. Legs 4 and 5 absent. Leg 6 present.

Other features as in the species described below.

Living in madreporarian corals.

Type and only known species: *Rhynchomolgus corallophilus*, new species.

Gender masculine.

Etymology.—The generic name is a combination of the Greek words ῥύγχος = snout, referring to the prominent rostrum, and μολγός = sack made of leather.

***Rhynchomolgus corallophilus*, new species**

FIGURES 80–115

TYPE MATERIAL.—45 ♀♀, 32 small ♂♂, and 47 large ♂♂ from the coral *Psammocora contigua* (Esper) in a depth of 1 m, southeast of Ambariobe, near Nosy Bé, Madagascar. Collected Sept. 6, 1963. Holotype female, allotype large male, and 58 paratypes (20 ♀♀, 15 small ♂♂, and 23 large ♂♂) deposited in the United States National Museum, Washington; 21 paratypes (7 ♀♀, 7 small ♂♂, and 7 large ♂♂) in the Zoölogisch Museum, Amsterdam; and the remaining paratypes in the collection of A. G. Humes.

OTHER SPECIMENS (all from *Psammocora contigua* in 1–2 m at Ambariobe, collected during 1963).—16 ♀♀, 19 small ♂♂, and 25 large ♂♂, Sept. 8; 5 small ♂♂ and 9 large ♂♂, Sept. 17.

FEMALE.—Body (figs. 80, 81) with cephalosome greatly expanded laterally; segments of metasome and urosome relatively slender and somewhat contractile, the postgenital segments sometimes telescoped. Length (not including setae on caudal rami) 1.07 mm (0.89–1.24 mm) and greatest width 0.56 mm (0.49–0.63 mm), based on 10 specimens in average state of contraction. Two fully extended females 1.49 x 0.54 mm. Ratio of length to width of prosome (not including rostrum) 1.29:1. Segment of leg 1 fused with head, the only indication of separation being an indistinct transverse dorsal fold.

Segment of leg 5 (fig. 82) 91μ x 166μ. Genital segment wider than long, 130μ x 161μ, subrectangular in dorsal outline. Areas of attachment of egg sacs situated dorsolaterally, each area (fig. 83) bearing medially two spiniform setae, both about 19μ in length and directed posteriorly. Three postgenital segments 86μ x 109μ, 65μ x 86μ, and 60μ x 75μ from anterior to posterior. Last segment with a lobate dorsal flap over anal area; at either side of this flap on both dorsal and ventral surfaces a patch of denticles. (Entire urosome in telescoped specimen shown in figure 3 about 325μ in length, but if expanded the length would reach about 475μ.)

Caudal ramus (fig. 84) 44μ x 23μ, with ratio of length to width 1.91:1. Six short naked setae near distal end of ramus, the longest about 36μ. (Of these setae, one more dorsally placed than others, one on outer corner, and two median, shown partly retracted in figure, corresponding respectively to dorsal pedicellate seta, outer lateral seta, and two long median terminal setae seen in less modified lichomolgids such as *Lichomolgus*.) Ramus with a few minute spinules, small setules, and refractile points as shown in figure.

Dorsal surface of prosome with scattered refractile points and setules in metasomal region (as in figs. 80, 81); urosome with dorsal and ventral surfaces similarly ornamented (see fig. 82). Ratio of

length of prosome to that of urosome (in specimen shown in fig. 80) about 2.39:1, but this ratio subject to state of contraction.

Egg sac unknown, since none of females collected was ovigerous.

Rostrum (figs. 80, 81, 85) a conspicuous tumid snoutlike lobe bluntly rounded distally.

First antenna (fig. 86) 5-segmented and relatively short (about 80μ in length). Lengths of segments (measured along their posterior nonsetiferous margins) 21μ (25μ along anterior margin), 15.5μ, 16μ, 11.5μ, and 9μ, respectively. Formula for armature: 3, 10, 4+1 aesthete, 2+1 aesthete, and 7+1 aesthete. Setae with strong lateral spinules, except five naked setae (one on segment 3, one on segment 4, and four on last segment).

Second antenna (fig. 87) 4-segmented and much longer (about 180μ including claw) than first antenna. First and second segments rather large and each with an inner barbed seta. Third and fourth segments smaller, third with three inner barbed setae, fourth (fig. 88) ornamented with five rather hyaline spinules and a short row of minute spinules, and bearing a terminal claw 28μ in length and only slightly recurved. External to base of second antenna and behind base of first antenna a prominent lobe (see figs. 81, 94).

Labrum (fig. 89) with posteroventral margin forming two lobes.

Mandible (fig. 90) with inner margin of basal region having proximally a prominent finger-like extension (directed posteriorly) and distally a row of small dentations; disto-inner margin of basal region with a row of moderately long spinules. Lash relatively short and not finely attenuated, with serrated margins. Paragnath (fig. 89) a small lobe bearing hairs distally. First maxilla (fig. 91) a single small segment with two terminal barbed setae. Second maxilla (fig. 92) 2-segmented, first segment unarmed, second with two barbed elements and extended to form a gladiate blade with short stout teeth along one edge. Maxilliped (fig. 93) 3-segmented, first segment unarmed, second segment with two spinulose elements, and third with one spinulose element and terminating in a spinulose spiniform process.

Area between maxillipeds and first pair of legs (fig. 94) not protuberant.

Legs 1–4 much modified. Legs 1 and 2 (figs. 95, 96) with similar intercoxal plates, protopods, and 2-segmented rami. In leg 1 terminal spine on exopod with a few inner serrations, and anterior surface of basis near insertion of endopod having a row of small spinules; these features absent in leg 2. Spines on both legs obtuse.

Leg 3 (fig. 97) reduced to two unequal setae, inner 7μ, outer 16μ in length. Leg 4 (fig. 98) a single seta 16μ long. These two legs lacking intercoxal plates.

Armature of legs 1–4 as follows (Roman numerals indicating spines, Arabic numerals setae):

P_1	protopod	0–0	1–0	exp	I–0	III,II,2
				end	0–0	I,1
P_2	protopod	0–0	1–0	exp	I–0	III,II,2
				end	0–0	I,II
P_3					2	
P_4					1	

In one female second segment of one endopod of leg 1 with an extra outer spine (I,I,1). In another female second segment of one exopod of leg 2 with an extra inner seta (III,II,3).

Leg 5 (fig. 99) without a free segment, and reduced to three setae, one dorsal 24μ, and two ventral 16μ and 18μ in length.

Color in life, in transmitted light, amber in cephalosome, rest of body translucent, eye red but indistinct.

SMALL IMMATURE MALE.—Body (fig. 100) elongated, rather vermiform, contractile, head region sometimes partly withdrawn into cephalosome and urosome often bent or contracted. Length (excluding setae on caudal rami) 1.17 mm (0.89–1.44 mm) and greatest width 0.26 mm (0.22–0.30 mm), based on 10 specimens not strongly contracted. Ratio of length to width of prosome about 2.61: 1. Segment of leg 1 fused with head.

Urosome (fig. 101) slender. Probably three postgenital segments, but their separation obscure, particularly between last two segments.

Caudal ramus (fig. 102) small, lobate, without distinct articulation with anal segment and bearing three spinules on dorsal surface (ventral surface smooth).

Surfaces of prosome and urosome apparently unornamented, though wrinkled condition of cuticula in preserved specimens makes this difficult to determine. Ratio of length of prosome to that of urosome (in specimen shown in fig. 100) about 1.40 : 1.

Rostrum (fig. 105) a tumid lobe as in female.

First antenna (fig. 103) 1-segmented, very short, about 44μ long, with 13 short terminal spines. Second antenna (fig. 104) probably 3-segmented (segmentation suggested by sclerites, no clear articulations present), about 64μ long. Last segment with eight short spines. External to base of second antenna and behind first antenna a conspicuous lobe (fig. 105), as in female.

Labrum a bulbous area between and behind second antennae, in ventral view (fig. 105) somewhat triangular and attached to a triangular sclerotized framework. Postlabral region forming a fold that slightly overlaps posterior end of labrum. Mouth region apparently located between labrum and postlabral fold. Mandibles, paragnaths, and first maxillae not discernible and apparently absent. Second

maxilla (fig. 106) a well-sclerotized recurved hook with a broad base perhaps representing a basal segment. Maxilliped (figs. 107, 108) with a prominent 1-segmented basal area bearing a well-sclerotized short clawlike tip.

Legs 1 and 2 similar in form, each leg far removed from its opposite member, without an intercoxal plate. Leg 1 (fig. 109), located near maxilliped (see fig. 105), with an indefinitely defined protopodal area, a slender setiform unsegmented exopod, and a rather weakly sclerotized unsegmented endopod bearing a single blunt hyaline seta (its articulation indistinct). Leg 3 (fig. 110) consisting of a single seta 22μ in length. Leg 4 absent.

Leg 5 absent.

Leg 6 (figs. 101, 111) consisting of a posteroventral flap on genital segment bearing a well-sclerotized spinous process and two setae 16μ and 22μ in length.

Spermatophores not formed in bodies of these small males.

Color in life, in transmitted light, opaque and grayish, eye not clearly visible.

Large mature male.—In the following description features not mentioned may be regarded as similar to those of the small male already described.

Body (fig. 112) elongated, vermiform, and contractile as in small male. Length (without setae on caudal rami) 2.04 mm (1.86–2.21 mm) and greatest width 0.46 mm (0.41–0.51 mm), based on 10 specimens. (Two other specimens much smaller, 0.69 x 0.18 mm and 0.86 x 0.18 mm). Ratio of length of prosome to that of urosome about 2.60:1.

Four postgenital segments, their separation more distinct than in small male.

Caudal ramus resembling that of small male but a little longer.

Ratio of length of prosome to that of urosome (in specimen shown in fig. 112) about 1.43:1.

Rostrum (figs. 113, 114) similar to that in female and in small male.

First antenna, second antenna, labrum, and postlabral fold as in small male. Mandibles, paragnaths, and first maxillae absent. Second maxillae (figs. 113, 115) represented by small well-sclerotized spinous processes. Maxilliped absent.

Legs 1–3 as in small male. Legs 4 and 5 absent.

Leg 6 (fig. 112) protruding a little more laterally, edge of posteroventral flap less sclerotized, and two setae relatively shorter (15μ and 18μ) than in small male.

Spermatophores fairly well developed inside about two-thirds of large males.

Color in life in transmitted light similar to that of small male.

ETYMOLOGY.—The specific name *corallophilus*, from the Greek words κόραλλον=coral and φίλος=loving, alludes to the association of this species with a coral.

SPECIFIC IDENTITY OF FEMALES, SMALL MALES, AND LARGE MALES.—The differences in external anatomy between males and females of *Rhynchomolgus corallophilus* are so striking that the question arises whether or not they represent opposite sexes of the same species. One can not fail to be impressed by the great difference between the males and females in body form, the nature of the first and second antennae, the labrum, the mouthparts (with mandibles, paragnaths, and first maxillae absent in males), and the form of legs 1–5 (with legs 4 and 5 absent in males). The differences in the second maxillae and maxillipeds in the two kinds of males (with the maxillipeds absent in large males) also contribute to the impression that they represent separate forms.

Since no specimens in our collections were in amplexus, judgment in respect to their specific identity must be made on other grounds than sexual behavior.

We believe that the three groups of specimens represent one species, *R. corallophilus*, for several reasons based on their external anatomy. Both kinds of males and the females have a similar snoutlike rostrum and all possess a prominent lobe external to the base of the second antenna. The small males and large males, differing in their second maxillae (reduced to a spinous process in large males) and maxillipeds (absent in large males), are otherwise similar in their appendages. It is our opinion that the small males are immature, and represent the last pre-adult instar. This interpretation is based on the facts that in small males there seem to be, at most, three postgenital segments and the body does not contain formed spermatophores, while in large males there are four postgenital segments and there are often partly formed spermatophores within. A molt from the small immature male to the large mature male would have to be presumed in order to account for the reduction in the second maxilla and the loss of the maxilliped.

Further justification for considering all three groups as one species may be found in the circumstantial evidence of the numbers of specimens collected. It would seem unlikely, if the males and females represent separate species, that large numbers of females of one species and large numbers of males of the other species would occur together in the same host without there being at least a few of the opposite sex in each case. For this to happen it would be necessary to suppose a very unequal and improbable sex ratio. We therefore

conclude that only one species is involved and that all the specimens represent *R. corallophilus*.

METHOD OF COLLECTION AND RELATION TO HOST.—*Rhynchomolgus corallophilus* apparently lives inside the polyps of the coral. When pieces of the coral were washed intact in alcoholized sea water within one or two hours after being brought into the laboratory, none of these copepods were obtained. After allowing the coral to remain overnight in the alcoholized sea water, considerable numbers were recovered from the sediment. After subsequently crushing the coral, still more *R. corallophilus* were found.

SYSTEMATIC POSITION OF THE NEW GENUS.—Several features of the female of *Rhynchomolgus* suggest that the genus belongs to the family Lichomolgidae. The mandible is lichomolgid in form, resembling rather closely that of *Lichomolgus rhadinus*. The second antenna, labrum, first maxilla, second maxilla, and maxilliped are also basically lichomolgid. The 5-segmented first antenna has fewer segments than in most other lichomolgid genera (where the number of segments is commonly seven). Apparently the reduction in the number of segments in *Rhynchomolgus* has involved the loss of segments 3 and 4, since the arrangement of the setae and aesthetes on the five segments corresponds rather closely (particularly on segments 3–5) to the pattern seen on segments 1, 2, 5, 6, and 7 of the 7-segmented first antenna of *Lichomolgus* and other lichomolgid genera.

There are obvious differences in legs 1–4 between the female of *Rhynchomolgus* and other lichomolgid genera, but these may be attributed to reduction associated with a parasitic way of life. Reduction of legs 1–4, so pronounced in both sexes of *Rhynchomolgus*, is known to occur to a lesser extent in certain other parasitic or associated lichomolgid genera, for example, in *Meomicola* Stock, Humes and Gooding, 1964, and in a new genus from zoanthid coelenterates whose description by Humes and Ho is in press.

Since the male of *Rhynchomolgus* lacks mandibles, paragnaths, and first maxillae, it is more difficult in this sex to demonstrate lichomolgid affinities. The sexual dimorphism seen in the first antenna, second antenna, second maxilla, and maxilliped makes comparison uncertain. However, following our opinion expressed above on the specific identity of the males and females, the males are included with the females as one species in the lichomolgid genus *Rhynchomolgus*. As far as known, no other genus of the Lichomolgidae lacks mandibles, paragnaths, and first maxillae in the male.

Literature Cited

BRADY, G. S.

1910. Die marinen Copepoden der deutschen südpolar-Expedition 1901–1903, I: Uber die Copepoden der Stämme Harpacticoida, Cyclopoida, Notodelphyoida und Caligoida. *In* Deutsche Südpolar-Expedition, 1901–1903, vol. 11, zool. vol. 3, no. 5, pp. 499–593.

GURNEY, R.

1927. Zoological results of the Cambridge expedition to the Suez Canal, 1924, XXXIII: Report on the Crustacea: Copepoda (Littoral and Semi-parasitic). Trans. Zool. Soc. London, vol. 22, pt. 4, pp. 451–577.

HUMES, A. G.

1960. New copepods from madreporarian corals. Kieler Meeresforsch., vol. 16, no. 2, pp. 229–235.

1962a. Eight new species of *Xarifia* (Copepoda, Cyclopoida), parasites of corals in Madagascar. Bull. Mus. Comp. Zool., vol. 128, no. 2, pp. 37–63.

1962b. *Kombia angulata* n. gen., n. sp. (Copepoda, Cyclopoida) parasitic in a coral in Madagascar. Crustaceana, vol. 4, pt. 1, pp. 47–56.

HUMES, A. G., and FROST, B. W.

1964. New lichomolgid copepods (Cyclopoida) associated with alcyonarians and madreporarians in Madagascar. Cahiers ORSTOM Océanogr., 1963, no. 6 (sér. Nosy Bé II), pp. 131–212.

HUMES, A. G., and HO, J.-S.

1967. New cyclopoid copepods associated with the alcyonarian coral *Tubipora musica* (L.) in Madagascar. Proc. U.S. Nat. Mus., vol. 121, no. 3573, pp.1–24.

In press. New lichomolgid copepods (Cyclopoida) from zoanthid coelenterates in Madagascar.

SEWELL, R. B. S.

1949. The littoral and semi-parasitic Cyclopoida, the Monstrilloida and Notodelphyoida. John Murray Exped., 1933–34, Sci. Reps., vol. 9, no. 2, pp. 17–199.

STOCK, J. H.

1959. Copepoda associated with Neapolitan invertebrates. Pubbl. Staz. Zool. Napoli, vol. 31, no. 1, pp. 59–75.

STOCK, J. H.; HUMES, A. G.; and GOODING, R. U.

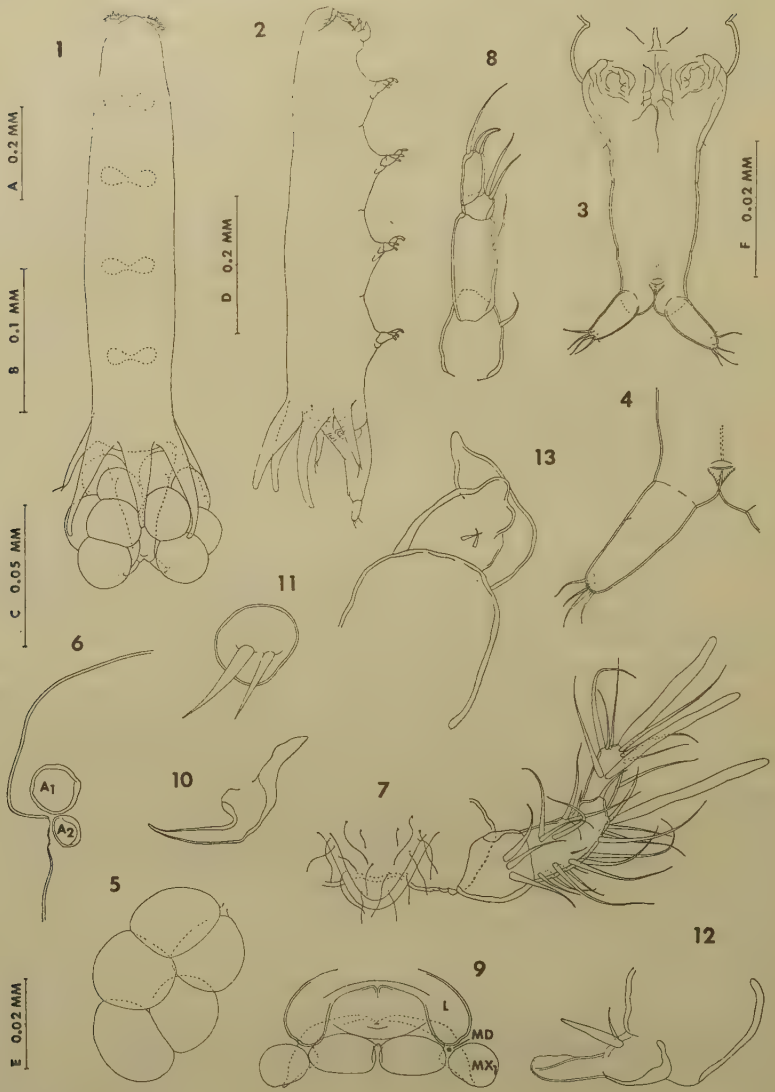
1964. Copepoda associated with West Indian invertebrates, IV: The genera *Octopicola, Pseudanthessius* and *Meomicola* (Cyclopoida, Lichomolgidae). Stud. Fauna Curaçao and other Caribbean Islands, 1963, vol. 18, no. 77, pp. 1–74.

THOMPSON, I. C., and SCOTT, A.

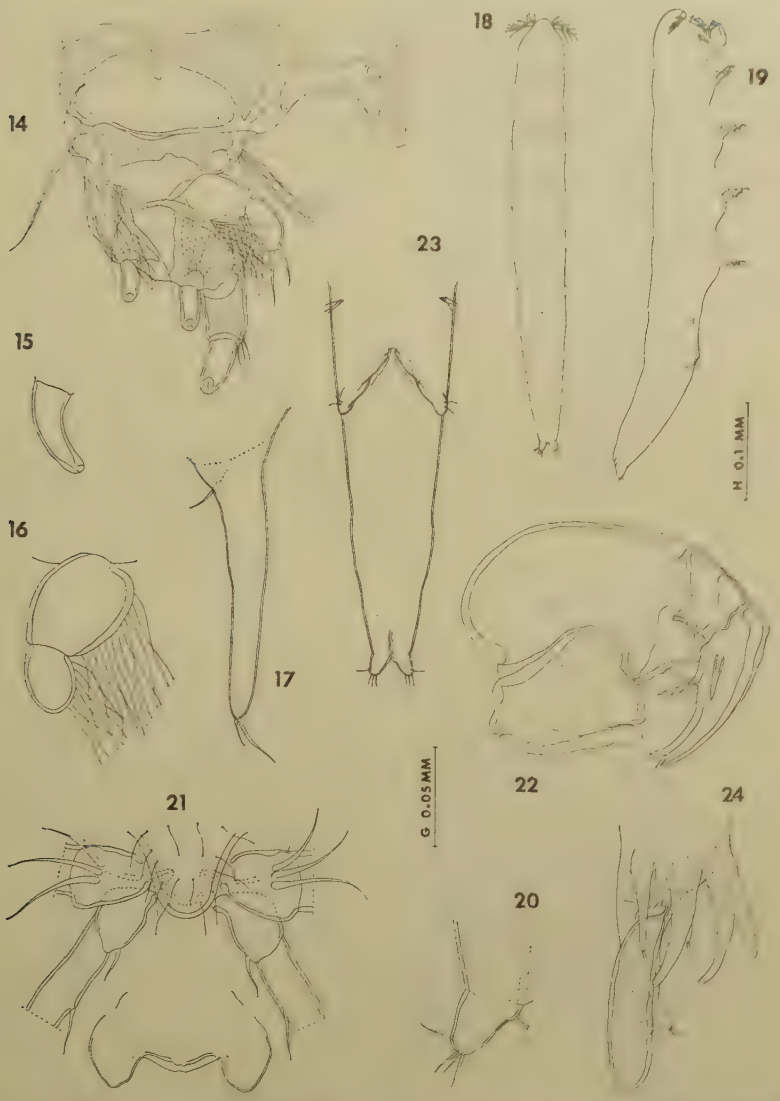
1903. Report on the Copepoda collected by Professor Herdman, at Ceylon, in 1902. Rep. Gov. Ceylon Pearl Oyster Fish. Gulf of Manaar, suppl. reps., no. 7, pp. 227–307.

UMMERKUTTY, A. N. P.

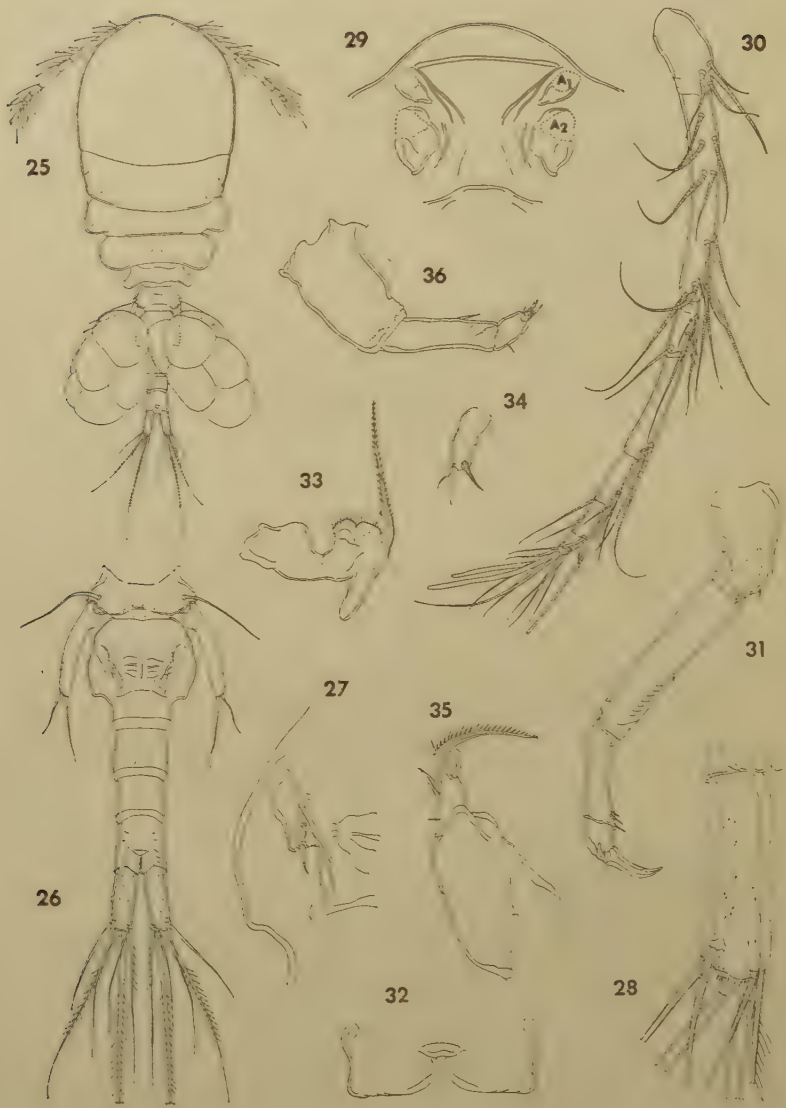
1962. Studies on Indian copepods, 5: On eleven new species of marine cyclopoid copepods from the south-east coast of India. Journ. Mar. Biol. Assoc. India, 1961, vol. 3, nos. 1 and 2, pp. 19–69.



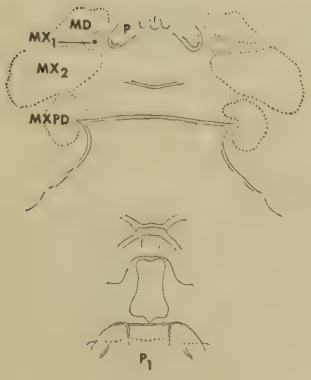
FIGURES 1–13.—*Xarifia diminuta*, new species, female: 1, dorsal (A); 2, lateral (A); 3, genital and postgenital segments, dorsal (B); 4, caudal ramus, dorsal (C); 5, egg sac, lateral (D); 6, outline of rostrum, lateral (C); 7, rostrum and first antenna, anterodorsal (E); 8, second antenna, lateral (E); 9, labrum, posteroventral (E); 10, mandible, anterior (F); 11, first maxilla, ventral (F); 12, second maxilla, anterior (F); 13, maxilliped, anterior (F).



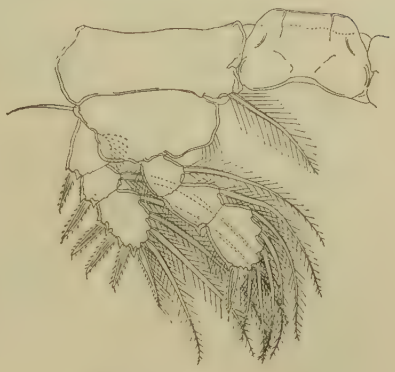
FIGURES 14–24.—*Xarifia diminuta*, new species, female: 14, leg 1 and intercoxal plate, posterior (E); 15, terminal spine on exopod of leg 1, lateral (E); 16, endopod of leg 3 posterior (F); 17, leg 5, medial (G). Male: 18, dorsal (A); 19, lateral (A); 20, caudal ramus, dorsal (C); 21, rostral area and labrum, anterior (E); 22, maxilliped, medial (E); 23, urosome, ventral (H); 24, spermatophore, attached to female, lateral (D).



FIGURES 25–36.—*Lichomolgus rhadinus*, new species, female: 25, dorsal (A); 26, urosome, dorsal (H); 27, area of attachment of egg sac, dorsal (C); 28, caudal ramus, dorsal (C); 29, rostral area, ventral (B); 30, first antenna, dorsal (G); 31, second antenna, inner (G); 32, labrum, ventral (C); 33, mandible, anterior (C); 34, first maxilla, lateral (C); 35, second maxilla, anterior (C); 36, maxilliped, anterolateral (C).

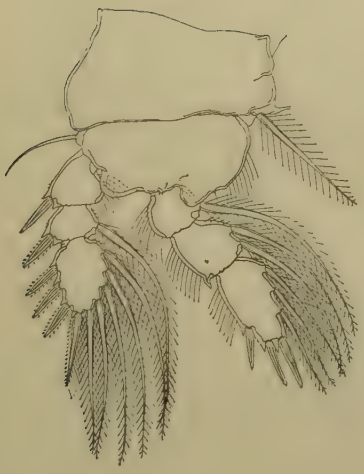


37

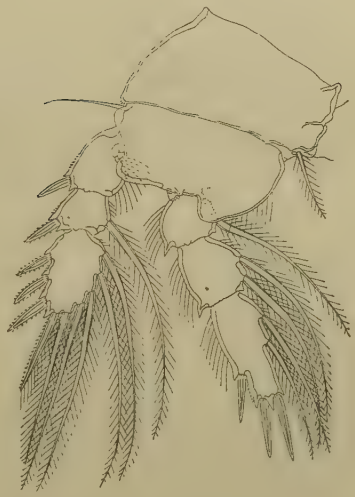


38

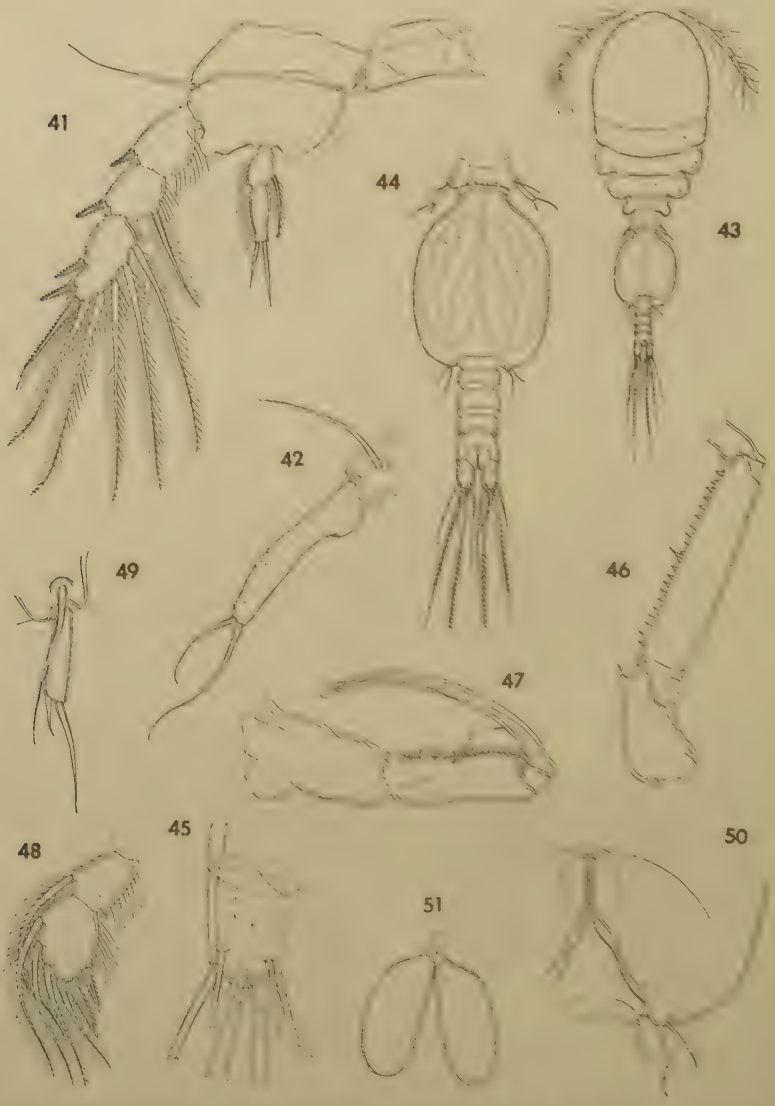
39



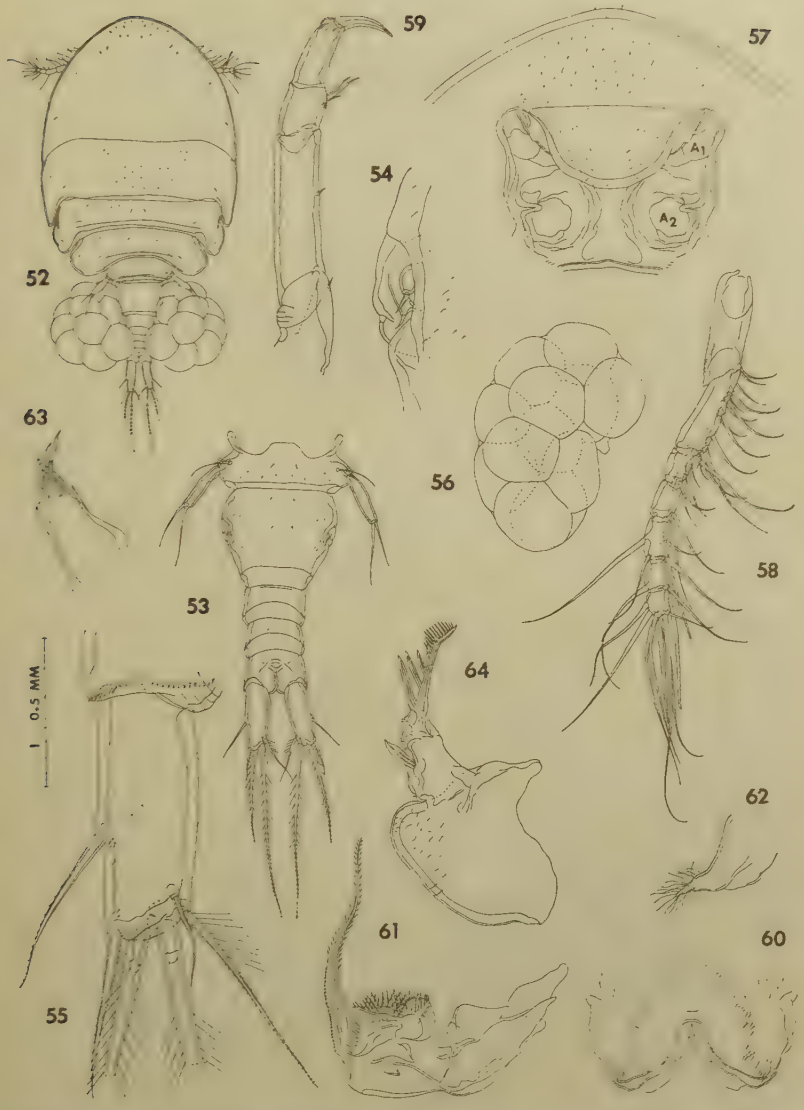
40



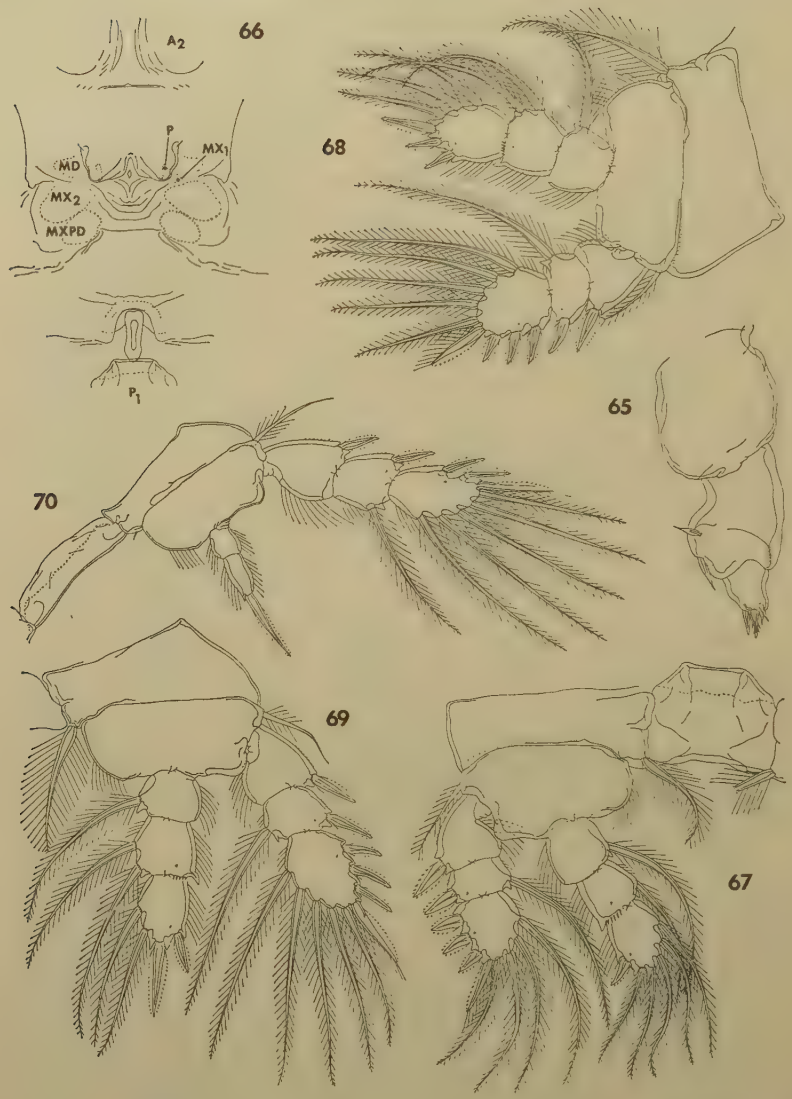
FIGURES 37–40.—*Lichomolgus rhadinus*, new species, female: 37, postoral area, ventral (G); 38, leg 1 and intercoxal plate, anterior (G); 39, leg 2, anterior (G); 40, leg 3, anterior (G).



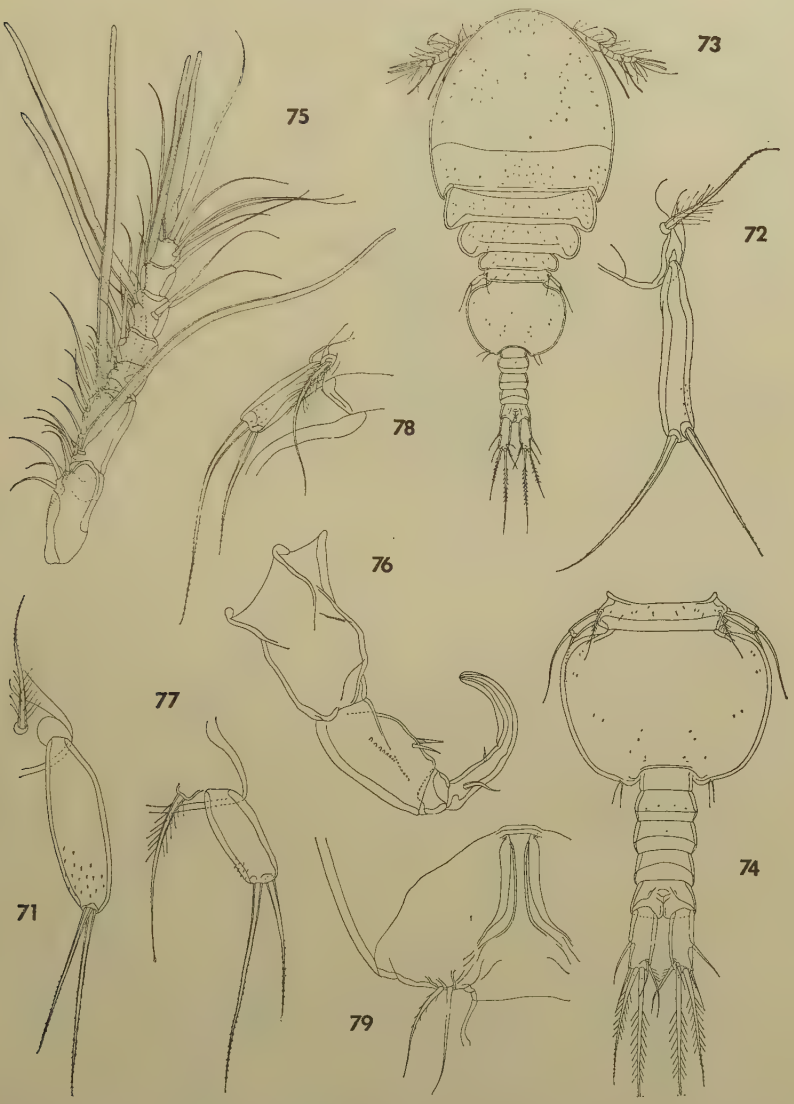
FIGURES 41–51.—*Lichomolgus rhadinus*, new species, female: 41, leg 4 and intercoxal plate, anterior (G); 42, leg 5, dorsal (G). Male: 43, dorsal (A); 44, urosome, dorsal (H); 45, caudal ramus, dorsal (E); 46, first two segments of second antenna, inner (C); 47, maxilliped, outer (G); 48, last two segments of endopod of leg 1, anterior (C); 49, leg 5, dorsal (E); 50, leg 6, ventral (C); 51, spermatophore, attached to female, lateral (H).



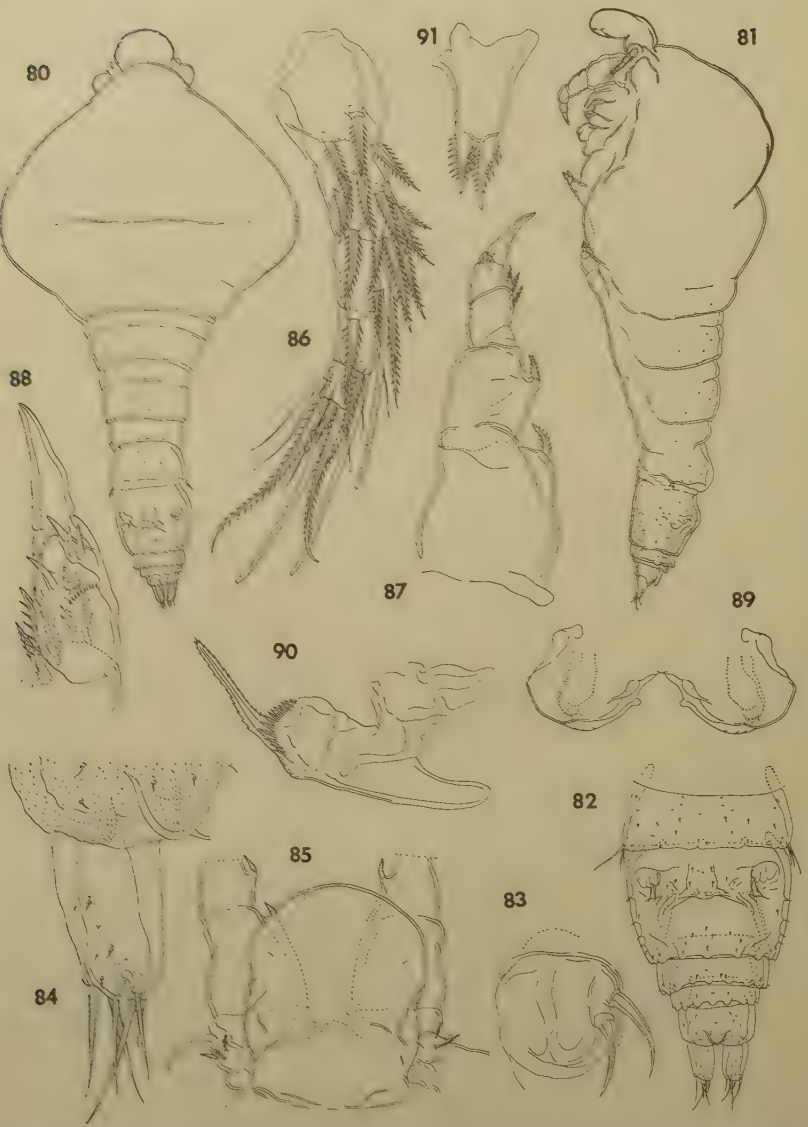
FIGURES 52–64.—*Monomolgus psammocorae*, new species, female: 52, dorsal (I); 53, urosome, dorsal (D); 54, area of attachment of egg sac, dorsal (C); 55, caudal ramus, dorsal (C); 56, egg sac, lateromedial (D); 57, rostral area, ventral (H); 58, first antenna, ventral (B); 59, second antenna, posterolateral (B); 60, labrum, ventral (G); 61, mandible, posterior (C); 62, paragnath, anterior (E); 63, first maxilla, posterior (C); 64, second maxilla, anterior (C).



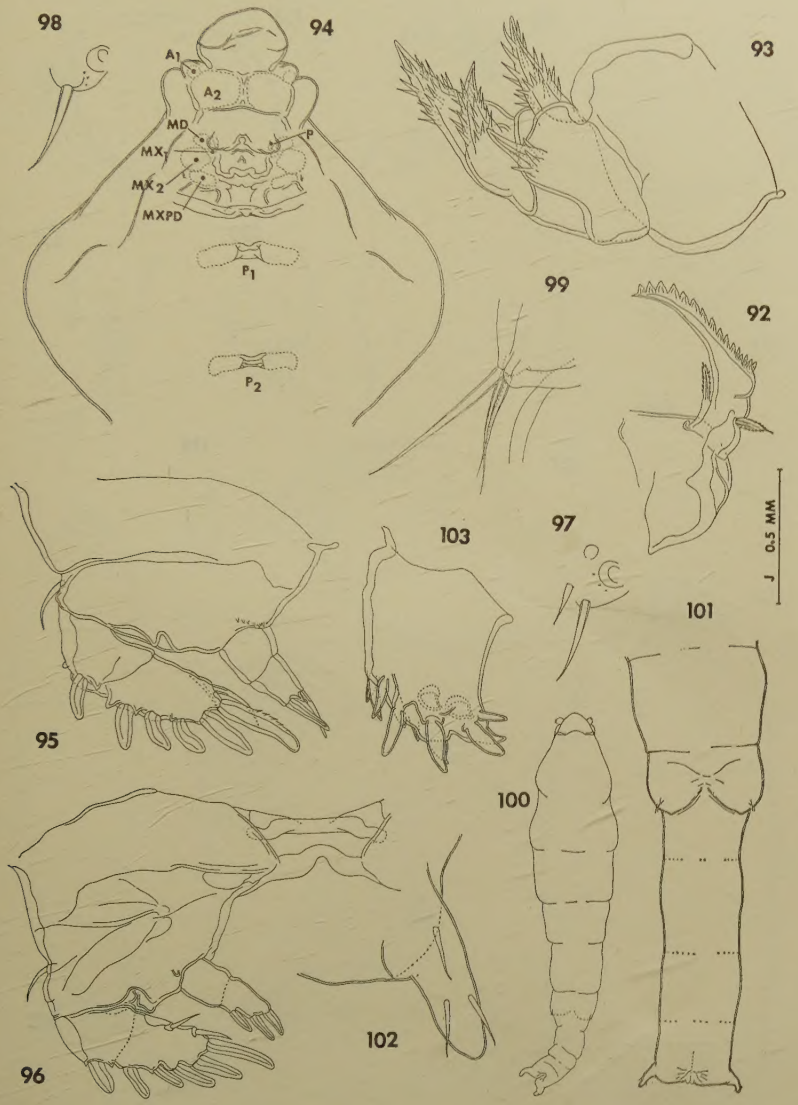
FIGURES 65–70.—*Monomolgus psammocorae*, new species, female: 65, maxilliped, anteromedial (C); 66, oral and postoral area, ventral (H); 67, leg 1 and intercoxal plate, anterior, (B); 68, leg 2, anterior (B); 69, leg 3, anterior (B); 70, leg 4 and intercoxal plate, anterior (B).



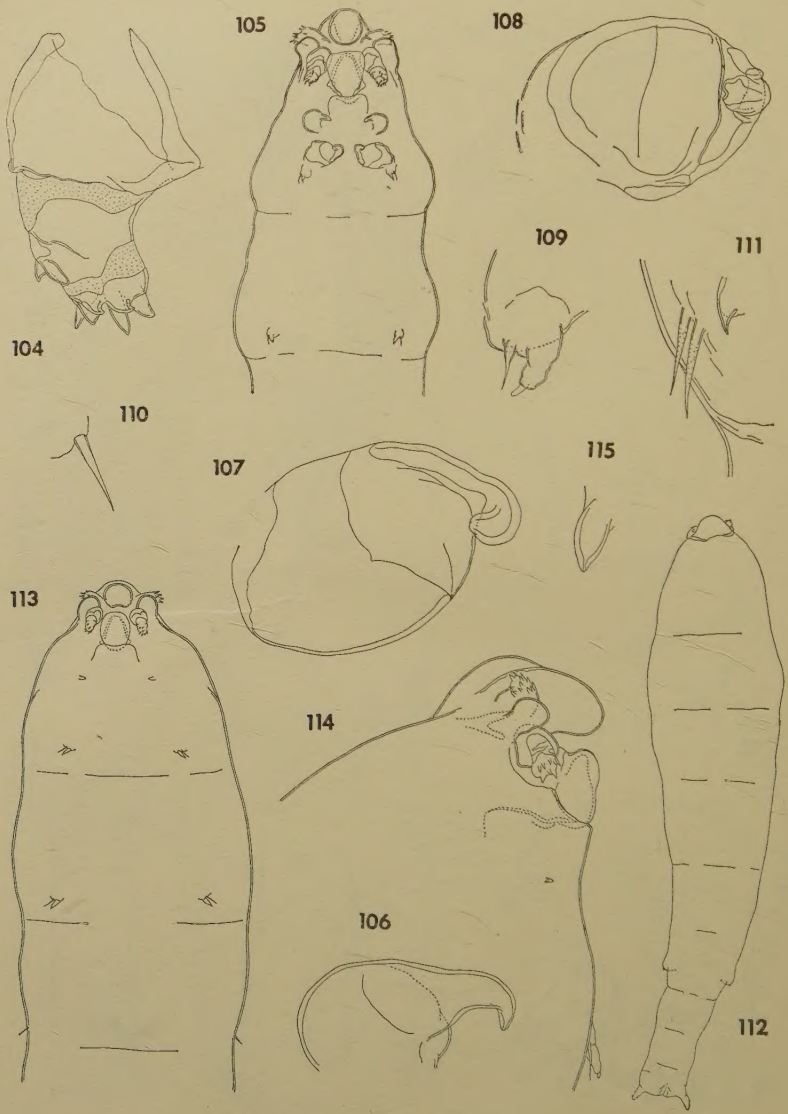
FIGURES 71–79.—*Monomolgus psammocorae*, new species, female: 71, leg 5, anterior (G); 72, leg 5, dorsal (G). Male: 73, dorsal (A); 74, urosome, dorsal (H); 75, first antenna, dorsal (G); 76, maxilliped, inner (C); 77, leg 5, somewhat anterior (C); 78, leg 5, dorsal (C); 79, leg 6, ventral (G).



FIGURES 80–91.—*Rhynchomolgus corallophilus*, new species, female: 80, dorsal (A); 81; lateral (A); 82, urosome, with postgenital segments telescoped, dorsal (H); 83, area of attachment of egg sac, dorsal (E); 84, caudal ramus, dorsal (E); 85, rostrum, dorsal (B); 86, first antenna, anterodorsal (E); 87, second antenna, anterior (G); 88, terminal segment and claw of second antenna, lateral (G); 89, labrum, ventral (G); 90, mandible, anterior (C); 91, first maxilla, anterior (E).



FIGURES 92–103.—*Rhynchomolgus corallophilus*, new species, female: 92, second maxilla, anterior (C); 93, maxilliped, posterior (E); 94, anterior part of body, ventral (D); 95, leg 1, anterior (E); 96, leg 2 and intercoxal plate, posterior (E); 97, leg 3, left side, ventral (E); 98, leg 4, left side, ventral (E); 99, leg 5, dorsal (E). Small immature male: 100, dorsal (J); 101, urosome, ventral (D); 102, caudal ramus, dorsal (E); 103, first antenna, ventral (E).



FIGURES 104–115.—*Rhynchomolgus corallophilus*, new species, small immature male: 104, second antenna, medial (E); 105, anterior part of body, ventral (D); 106, second maxilla, anterior (E); 107, maxilliped, ventral and slightly lateral (E); 108, maxilliped, ventra (E); 109, leg 1, ventral and somewhat anterior (E); 110, leg 3, ventral (E); 111, leg 6, ventral (E). Large mature male: 112, dorsal (J); 113, anterior part of body, ventral (A); 114, cephalosome, lateral (H); 115, second maxilla, ventral (E).

U.S. GOVERNMENT PRINTING OFFICE: 1967